OBSERVATIONS ON GERRIS INCOGNITUS AND GERRIS GILLETTEI (HETEROPTERA: GERRIDAE)

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ABSTRACT—Information is presented on identifying characteristics, size, sex ratio, wing polymorphism, migratory behavior, diving behavior, habitat, and life cycle of *Gerris incognitus* Drake and Hottes and *G. gillettei* Lethierry and Severin. The ecological importance of water striders in general is discussed.

Relatively little work has been done on the ecology and behavior of most North American water striders. Only *Gerris remigis* Say, the most common species, has received much attention (Torre-Bueno 1917, Essenberg 1915, Riley 1920, Murphey 1971a, 1971b). The purpose of this paper is to provide information on 2 of the most neglected gerrid species, *G. incognitus* Drake & Hottes and *G. gillettei* Lethierry & Severin, chosen because of their abundance in the study area.

Location and Methods

This study was conducted between April 23 and June 5, 1972, at Jewel Lake and 3 adjacent ponds, all located in Tilden Regional Park, Contra Costa County, California. Collecting was limited to the adults, as no key is available for identification of nymphs of these 2 species. A 4 in. × 6 in. short-handled dipnet proved most satisfactory for obtaining specimens, and on Jewel Lake it was used from an inflatable plastic raft. Screening was impractical due to the dense growth of pondweed and filamentous algae in the habitat of both species.

Results

1. Identification

Gerris incognitus and *G. gillettei* are similar in appearance and their identity has often been confused (Drake and Harris 1928). The females are particularly difficult to separate, as are those of several members of the genus (Sprague 1967). Under low magnification, males are easily distinguished by the presence, in *incognitus,* of long silvery hairs on either side of the ventral surface of the first genital segment (Usinger 1956). Other characteristics are given in some keys (Kuitert 1942) but were found to be less useful for identification.

Identification of females was achieved by the laborious process of obtaining copulating pairs, identifying the males, and using the

females as types for comparison with other females. Only those pairs captured while still mating were used for this purpose. It developed that the females of *gillettei* were larger in size and paler on the ventral surface of the abdomen than were those of *incognitus*. All females collected (88 individuals) could be separated by these criteria.

2. Size

Specimens were kept in containers without food for a week or more prior to measurement, in order to minimize errors which may result from the distention of the abdomen (Brinkhurst 1963). The insects were isolated from one another to prevent cannibalism.

Male *incognitus* ranged in length from 8 to 9.75 mm, with a mean length of 9.1 and a standard deviation of 0.4 mm. Females were 8.75 to 10 mm long, the mean being 9.1 $\pm$ 0.3 or virtually identical to that of the males. Drake and Harris (1934) reported the length of *incognitus* as 8.5 to 9.5 mm, presumably for both sexes.

The size range for male *gillettei* was 8 to 9.5 mm, $\bar{x} = 8.7$, S.D. = 0.3 mm. Females were 9.5 to 11.5 mm long, the first generation showing 2 subequal peaks at 10 and 11 mm respectively, and the second generation being almost uniform at 10 mm. The mean for all females collected was 10.3 $\pm$ 0.5 mm. The size discontinuity among the early migrants suggests 2 parent populations. Females of both size classes were found copulating with typical male *gillettei*.

3. Sex ratio

During late April and early May, males of *incognitus* outnumbered females by 4 to 1. The second generation was almost entirely female, however only a single male being found in a sample of 30 adults collected on June 5. This male was further distinguished by being the smallest (8 mm) and the only apterous male of this species collected. It was not a nymph, because it had 2 tarsal segments (Sprague 1967).

Females outnumbered males in both generations of *gillettei*. The ratio varied slightly from one week to the next, but it was approximately 3 to 1. The very unequal sex ratios found in both species may have contributed to the problems encountered by early collectors. If I had sampled the first generation without first observing behavior, I would have obtained primarily male *incognitus* and female *gillettei*. Without criteria for identifying females I would have concluded, not unreasonably, that all were *incognitus*.

4. Wing polymorphism

Forty-four of the 45 *incognitus* males collected were macropterous, the exception having been mentioned. Females (26 specimens) were

macropterous in the first generation and apterous in the second. Drake and Harris (1934) describe an apterous form for the female but not for the male of this species, although they do not actually state that the condition is rare in males.

A total of 29 male and 62 female *gillettei* were collected. The first generation was entirely macropterous, while in the second generation 50% of the males and 95% of the females were brachypterous and clearly flightless. Drake and Harris (1934) described both brachypterous and macropterous females, but they did not mention brachypterous males. Kuitert (1942) reported both apterous and macropterous forms, but did not describe the brachypterous condition.

Wing polymorphism in the British Heteroptera has been reviewed by Brinkhurst (1963), who described alternating long-winged and short-winged generations in several species of *Gerris*. To my knowledge, however, a similar phenomenon has not previously been reported for any North American water strider.

While no definite conclusions can yet be drawn, it seems probable that in *Gerris incognitus* and *G. gillettei*, as in other members of the genus, the macropterous first generation has the function of dispersal. The ecological significance of the flightless second generation is less clear, particularly in *gillettei* where flightlessness is much more prevalent among the females. Brinkhurst (1963), however, has suggested that the brachypterous condition may enhance reproductive ability.

5. Migratory behavior

In both species, adults of the macropterous first generation tended to migrate from Jewel Lake to the small ponds in Jewel Lake Meadow, approximately 300 yards away.

On April 23, when this investigation began, winged adults of *incognitus* were already present at Pond B. There was no way of determining whether these had over-wintered at the pond or had migrated earlier in the year. *G. gillettei* was at this time confined to Jewel Lake.

On May 2, following a period of warm weather, many *incognitus* and *gillettei* were found at nearby Flycatcher Pond, where previously there were no gerrids. These migrants had evidently come from Jewel Lake, as neither species was found elsewhere in the Park. The *incognitus* population of Pond B appeared to have increased markedly as well; but this pond supports a dense growth of cattails (*Typha*) where the insects could easily hide, so the apparent increase in the latter instance cannot be taken as positive proof of migration.

Subsequent migrations of the 2 species occurred throughout the study period, but were somewhat limited by the predominance of wingless *incognitus* and of short-winged *gillettei* in the second gen-

eration. All macropterous adults of *incognitus* disappeared between May 21 and May 30, after which the *incognitus* population, both at the ponds and at Jewel Lake, consisted almost entirely of apterous females. Winged and short-winged *gillettei* were still present at both locations on June 5 when the study was concluded.

Water striders are generally thought to migrate on moonlit nights (Usinger 1956). *Gerris marginatus* has also been reported to fly at dusk (Riley 1920). During the present study, however, one of the largest migrations took place between May 11 and 12, when there was no moon. The latter observation would appear to contradict the belief that the insects find water solely by reflected moonlight (Riley 1920). Nor are there artificial lights near the ponds.

Both *incognitus* and *gillettei* can be induced to fly during the day. On the afternoon of May 12 I released a mixed sample of 20 adults, dropping them from a height of 3 feet onto the surface of Pond B. About 6 of these veered off before landing, and flew in a straight line to the southwest. This course, if maintained, would have brought them to Jewel Lake; but due to the small size of the insects it was impossible to follow them through the woods. These events suggest the possibility of daytime migration under normal circumstances. Further evidence is the presence of gerrids in the stomachs of Purple Martins, *Progne subis* (Linnaeus), birds which are diurnal in their habits and feed mainly on flying insects (Beal 1918). The problem here is that Martins, like other swallows, drink by skimming the surface of streams and ponds, and would therefore be in a position to catch even wingless gerrids.

There has been some disagreement as to whether the migration of water striders involves orientation. Riley (1920) believed that the insects merely fly in all directions when their pond dries up. He discussed hydrotropism as a possible factor, but concluded that it is probably of little importance. In 1922, however, Parshley reported observations which are difficult to explain without postulating some method of orientation. He had found only 1 winged individual of the gerrid *Rheumatobates rileyi* Bergroth among thousands of apterous specimens from an area examined over a three-year period; yet on 1 occasion he found 6 winged migrants of the species at a small nearby pond. He knew these were migrants because the pond had recently been oiled to kill mosquito larvae. If macropterous *R. rileyi* are that uncommon it appears unlikely that 6 could have converged on a small pond by accident alone.

Migration may possibly involve orientation by polarized light, as suggested by the work of Bohn and Tauber (1971) and by the fact that all migrations seem to occur during clear weather. In general, however, gerrid migration remains a poorly understood phenomenon.

6. Diving behavior

On June 5, while collecting at Jewel Lake, I observed 2 instances of diving. In 1 case the insect involved was clearly a macropterous *gillettei*, observed from a distance of approximately 8 inches. It skated toward the edge of my raft and abruptly disappeared beneath the surface. A few seconds later a similar water strider popped up at the other side of the raft. Regardless of whether this was the same individual, the initial act of diving was unmistakable. Another water strider was also seen to dive, but it was several feet away and the species could not be determined. In this instance I had been pursuing the insect and it apparently dived to escape, although none of the others had ever shown this reaction when pursued. Certainly the hydrofuge pile would have prevented its remaining submerged for very long, unless by clinging to the *Potamogeton* which grows abundantly in the lake.

I have found no report of diving behavior in any North American water strider. Torre-Bueno (1917) wrote: "It is said that when closely pursued *Gerris* dives to escape and swims under water, but I have never been able to induce or force any of those I have seen to perform for me." One of the reviewers of the present paper went so far as to state that "no species of *Gerris* or any other water strider is physically able to dive beneath the surface film."

Among European entomologists, on the other hand, it seems generally accepted that *Gerris* can dive. Brinkhurst (1960) has shown that female *G. najas* migrate beneath the surface to lay their eggs. Miall (1922) wrote that "*Gerris* dives occasionally but not often, and never when avoiding pursuit," and added that diving is more frequent in nymphs than in adults. Bertrand (1954), referring to some unspecified paper by Brocher, wrote that "il semble . . . qu'a l'occasion ils puissent pénétrer sous l'eau."

This apparent paradox may be explained by the simple fact that *Gerris remigis* does not dive. As was previously noted, this is the only North American gerrid which has been adequately studied.

7. Distribution

Gerris incognitus is particularly common in the North and Northwest, having been reported from Quebec, British Columbia, Washington, Oregon, Idaho, Montana, and California (Drake and Harris 1934). *Gerris gillettei* overlaps much of its range but has a more southern distribution; it occurs in Washington, Oregon, Montana, Colorado, Texas, Utah, and California (Drake and Harris 1934). It may therefore have an advantage at higher temperatures, as suggested by the fact that it was about 5 times as abundant as *incognitus* in early June, when the surface of Jewel Lake approached 37 C.

Earlier in the year the situation was reversed, *incognitus* being far more abundant than *gillettei*.

The literature contains almost no information on the habitat of either species. Torre-Bueno (1913) reported only that *gillettei* was found on brackish water in Utah. In Tilden Park during the study period, the 2 species occurred together above *Potamogeton* beds in Jewel Lake and in smaller numbers on the ponds. Associated species were *G. notabilis* and occasional *G. remigis* migrants.

8. Generation time

Gerris gillettei appears to have a shorter life cycle than does either *G. remigis* (46 days, Torre-Bueno 1917) or *G. notabilis* (43 days, Callahan 1972). The first winged *gillettei* adults arrived at Jewel Lake Meadow on May 1 or 2, and the first brachypterous individuals had reached the adult stage on May 30. The generation time must therefore be 28 days or less. Similar information is not available for *incognitus*, because its date of arrival at the ponds is not known.

9. Ecological role

It is often assumed that gerrids are quite irrelevant. A careful examination of the literature reveals the fallacy of this assumption, and emphasizes the importance of preserving the habitat of every organism whose value has not been analyzed.

Water striders may provide an important source of animal food for the Wood Duck, *Aix sponsa* (Linnaeus), and are eaten by other ducks (Mabbott 1920, McAtee 1918), shorebirds (Wetmore 1925), and swallows (Beal 1918). Drake (1914) found significant numbers of *Gerris* in stomachs of the Leopard Frog, *Rana pipiens* Shreber. At Jewel Lake, *G. incognitus* and *G. gillettei* were almost certainly taken by the Bullfrog, *Rana catesbeiana* Shaw (personal observations). Despite Usinger's (1956) assumption that water striders are not eaten by fish, an examination of the stomach contents of 8 rainbow trout fry taken at San Leandro Creek revealed that one had fed on *Gerris* nymphs (Callahan 1972). Schlichting and Sides (1969) have shown that migrating water striders play an important role in the transport of aquatic microorganisms, including algae, protozoa, fungal spores, and copepod nauplii, from one location to another.

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